

A REVISION OF THE GENUS *CLETHRA* IN CHINA

SHIU-YING HU

TWENTY SPECIES OF *CLETHRA* have been recorded from China. Ninety per cent of these were described as new entities. These descriptions were prepared by British, French, American, Austrian, Dutch, and Chinese botanists, and their research was conducted in nine different European and American botanical institutions. In reviewing their work, it becomes apparent that some of them had no proper understanding of the variability of a species of *Clethra*. Consequently, repetition and confusion were created for the taxonomy of the Chinese species. Under these conditions the naming of a new collection of *Clethra* becomes a seemingly hopeless task. Even in the herbarium of the Arnold Arboretum where outstanding collections of Chinese specimens, including many types and photographs of types accompanied by fragments of the type-material, are deposited, one found it difficult to name an unidentified specimen of *Clethra*. A generalized treatment of the genus which contains a well-balanced key to the species and concise descriptions of them to aid in the identification of specimens is lacking. To supply such a treatise is the immediate aim of this revision.

The genus *Clethra* has an Asiatic-American distribution. An analysis of the countries of origin of the species as listed in the *Index Kewensis* shows that China and Mexico have the largest numbers of species. Careful examination of the species described from these two countries and their adjacent land-masses indicates that morphological variations among the Chinese species are far more diverse than among their tropical American allies. Actually, all the outstanding morphological features of the American species can be found among some of the Chinese species; yet the variations of certain Chinese forms are not to be found among the New World species. For this reason, a systematic revision of the Chinese *Clethra* has a more far-reaching significance than the merely utilitarian aim mentioned above. It seems that the problems involved in the classification of Chinese *Clethra* constitute the core of investigations which may lead to an understanding of the morphology, taxonomy, and geographical distribution of the genus as a whole. A proper knowledge of the Chinese species may throw some light on future studies of the American species.

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Unless accompanied by a note of explanation, all the specimens cited in this article are deposited in the herbaria of the Arnold Arboretum and the Gray Herbarium.

HISTORY

The genus *Clethra* was established on a North American species, *C. alnifolia*, originally known to European naturalists from Carolina and Virginia. The name *Clethra* (derived from the ancient Greek name for the alder, *klethra*, in allusion to the resemblance of the leaves of the type species to those of *Alnus*) first appeared in Gronovius' *Flora Virginica*, published in 1739. When Gronovius created this name he cited two earlier references, one from Plukenet's *Phytographia*, published in 1691, and the other from Catesby's *The Natural History of Carolina*, published from 1731 to 1743. He even quoted Catesby's diagnostic comment on the taxon intact, "Alni folia Americana serrata, floribus pentapetalis albis, in spicam dispositis." Linnaeus used Gronovius' name, giving the same quotation. A specimen of *C. alnifolia* is preserved in the Linnaeum herbarium, number 567.1. The species was introduced into European gardens in the early eighteenth century.

For a century and a quarter after the establishment of the genus, the classification of *Clethra* was based principally on American species. In 1839, De Candolle, in his *Prodromus*, placed *Clethra* in the tribe Andromedae of the family Ericaceae. His description of the anthers represented an erroneous observation. Apparently he mistook the developmental stage in the flower bud to be the mature anther and, though he did mention the inversion, he interpreted the cordate portion as the base and the mucronate and muticous end as the apex. In regard to the classification of the species, he arranged those known at that time in two sections, *Euclethra* and *Cuellaria*. He characterized his section *Euclethra* as having exserted stamens and pistils and deciduous leaves, and placed five North American species in this section. He characterized the section *Cuellaria* as having the stamens and pistils included and assigned 17 species from Central and South America and a single species from the Madeira Islands to this section. Although Blume had published *C. canescens* Reinw. from Celebes and Borneo, De Candolle did not include this species in his system.

In 1851 in an article, *Studien über die natürliche Klasse Bicornes*, Klotzsch separated *Clethra* from the family Ericaceae and raised it to a family, Clethraceae, on the strength of its choripetalous corolla, corolla and stamens deciduous after anthesis, its obcordate anthers which are retroflexed at first and then introrse and dehiscent by apical rimiform pores, and its bifid or trifid stigmas.

The portion of the Bentham and Hooker's *Genera Plantarum* that covers *Clethra* was prepared by Hooker. In this work Hooker placed *Clethra* at the end of the family Ericaceae as "Genus Anomalum." By this time several species had been introduced into cultivation in England, e.g., *C. arborea* from the Madeira Islands, *C. quercifolia* from Jalapa in Mexico, *C. tomentosa* and *C. alnifolia* from eastern North America. With live plants as well as herbarium specimens at his disposal, he gave the most accurate description of the important characters of the genus. Re-

garding the anthers, he pointed out that they are affixed at the middle of the back, are often obovate in shape and acute at the base, are extrorse at first then turning introrse, and dehisce above the middle by elongate pores.

The Chinese *Clethra* were not known to botanists until 1883. In that year Hance published *C. faberi* from Loh-fau Mountain of Kwangtung Province. Two years before this, Franchet, in his *Plantae Davidianae*, had published *Clethra scandens*. However, this species is not a true *Clethra*, and since then has been made the type species of the genus *Clematoclethra* Maxim.

When Hemsley prepared the enumeration of the plants from China, he saw Henry's collections of *Clethra* from Hupei. He was indeed not critical in his observation. In publishing Forbes and Hemsley's *Index florae sinensis* in 1889, he treated Henry's collections as *C. canescens* Reinw., a species known only from Western Malaysia. In the same work he reduced *C. faberi* Hance (from Kwangtung), *C. lancifolia* Turcz. (from the Philippines), and *C. barbinervis* Sieb. & Zucc. (from Japan) to *C. canescens*.

In the same year O. Drude published his contributions on Clethraceae, Ericaceae, and other related families in Engler and Prantl's *Die natürlichen Pflanzenfamilien*. In this work Drude accepted Klotzsch's proposal of raising the genus to a family and in the description of the genus, followed Hooker. In the classification of the species, he adopted De Candolle's two sections and placed the Asiatic species *C. barbinervis* in section *Euclethra*. He separated *C. arborea* Ait., a species from the Madeira Islands, from section *Cuellaria* and assigned it to an unnamed section which he placed between *Euclethra* and *Cuellaria*.

Meanwhile, material collected by French missionaries who were stationed in central and western China reached Paris. Franchet in 1895 published *C. fargesii* from eastern Szechuan and *C. delavayi* from western Yunnan. Incidentally, these species define the northern and western limits of the range of the genus in China.

Bodinier, Cavalerie and Esquirol were French missionaries who were sent to Kweichow in later years. Their collections reached Lévêillé who in 1912-3 published six more species of *Clethra*: *C. bodinieri*, *C. cavaleriei*, *C. esquirolii*, *C. kaipoensis*, *C. lineata* and *C. pinfaensis*. As indicated by a key to these species which he prepared in the *Flore du Kouy-Tchéou*, Lévêillé observed several characters which are important for distinguishing the Chinese species of *Clethra*. He observed that some species possess entire stigmas, while others have lobate or cleft ones. He also noticed that some species have elongate pedicels, while others have short ones. The arrangement of the racemes was also mentioned in his key, as some were umbellate while others were solitary.

After E. H. Wilson returned from his third trip to West China, Rehder and Wilson worked cooperatively on Wilson's numerous collections. In 1913, they described *C. monostachya*, a species characterized by its pilose styles. When Rehder worked over the ligneous plants described by Lé-

veillé, he was able to examine the types of Lévêillé's six species of *Clethra* which were described from Kweichow. In 1934 Rehder recognized three of them and merged *C. esquirolii* and *C. lineata* with *C. cavaleriei* and *C. pinfaensis* with *C. kaipoensis*.

Aside from the species described by these workers, seven additional binomials were added to the genus by Handel-Mazzetti, Sleumer, Hao, Fang, and Li. None of these authors seems to have attempted to place his species in the existing taxonomic system, and some of these names are synonymous with earlier described species.

TAXONOMIC CHARACTERS

Habit of growth. The species of *Clethra* generally have the habit of growth common in the family Ericaceae. The branches have subverticillate branchlets with leaves crowded at the apex. The majority of the Chinese species are deciduous and two of them are evidently evergreen.

In the deciduous species, each vegetative branchlet has a large, sessile terminal bud and 1–3 subterminal axillary buds (FIG. 24, right). In the following year, the large terminal bud of a mature plant develops into a flowering shoot provided with a few smaller leaves, a bracteate raceme or panicle, and 1–3 axillary buds immediately below the inflorescence (FIG. 24, left). The subterminal buds of a vegetative branchlet and the axillary buds of a flowering branchlet are of the same nature and function. They are all active during the growing season and consequently attain various stages of development before the leaves fall in the autumn. The more vigorously growing ones develop into stems 4–6 cm. long, each bearing 3 or 4 leaves crowded at the shoot apex around the terminal winter bud. The weaker ones generally develop into short stems 1–2 cm. long, each bearing 1 or 2 very small, bract-like leaves surrounding the terminal winter bud. Often the stem-portion becomes so short that the bud appears as though it were a stalked winter bud. In this case, it bears no leaf. In the next growing season these winter buds either unfold and develop into short vegetative shoots with large leaves and strong, fat terminal buds ready to produce flowers the third year, or they may develop into flowering shoots, depending upon the vigor of the plant, the environmental condition, and the heredity of the species.

In an evergreen species, an average branchlet of a mature plant is usually a flowering branchlet (FIG. 25). From one to four axillary buds immediately below the inflorescence develop into leafy shoots, each bearing a terminal bud and several normal leaves crowded at the apex. Normally, this terminal bud produces a flowering shoot during the next growing season. The inflorescences of the Chinese evergreen species are all simple racemes.

Schneider in 1910 observed the evergreen habit of *C. arborea* Ait. and used it as a key character in the classification of the then-known cultivated species of *Clethra*. With the Chinese species the evergreen habit

is correlated with an entire stigma. It is an obvious key character for distinguishing species.

Leaves. The leaves on the branchlets of a deciduous species are of two kinds. Those developed from a winter bud are the normal leaves and are usually the larger ones. Those developed from axillary buds which become active during the same season in which they are produced are always smaller and narrower. They often become bract-like and are more pubescent than the normal leaves on the same plant. In the study of *Clethra*, whenever the comparison of leaf-characters is employed, care must be exercised so that the comparison is made between leaves of the same origin. With the Chinese species, the normal leaves of a species seem to be quite stable in shape, indumentum, dentation and venation. Any variation occurring in these respects is usually correlated with some flower character, and, for this reason, the leaf-characters are used as auxiliary criteria for distinguishing species.

Inflorescences. The Chinese species of *Clethra* are summer bloomers. The earliest flowering species, *C. bodinieri*, begins to flower in June and its fruits mature in early August. The latest flowering species, *C. kaipoensis*, is in full bloom in middle September. The majority flower in July and August, however.

The inflorescences of most Chinese species of *Clethra* are either simple terminal racemes (Figs. 25, 26), or paniculate racemes. The panicles are sessile and subumbelliform (Fig. 27). The inflorescences of weak or old branchlets of a species normally bearing panicles may appear simply racemose. However, a good specimen of the species usually has paniculate inflorescences. The form of inflorescences, when correlated with leaf and flower characters, is a convenient and rather reliable character for distinguishing species. For this reason, it has been used as a key character in most manuals.

Rachis. The rachises of all the species of *Clethra* are densely pubescent. Those of the majority of the Chinese species have stellate hairs, but the rachises of *C. bodinieri* have simple, straight, appressed hairs. The type and density of the indumentum on the rachises is a useful aid in the recognition of species.

Bracts. The bracts subtending individual flowers have been used by American botanists for distinguishing *C. alnifolia* and *C. acuminata*. Some botanists put special emphasis upon the relative length of the bracts and the flowers. Actually, the bract is a rather poor character to employ for distinguishing species, for the bracts of *Clethra* are caducous. In general, the first opened flower of a raceme is situated a little below the middle of the inflorescence and the other buds open progressively towards both ends. The bracts and the mature flowers are not present at the same time (Figs. 26, 27). It is only when the inflorescences are in the bud stage that the flower buds are subtended by bracts. The degree

of maturity of the inflorescence makes a great difference in the relative length of the bracts and the flowers. This character should be used with great caution. It can never be used as the only criterion for distinguishing species.

Pedicels. The pedicels of *Clethra* exhibit a definite pattern of elongation during anthesis. As illustrated by FIGS. 1–6, which show stages from a fully grown flower bud to the dropping of the petals, the pedicels normally increase three times in length. The lengths of the pedicels of individual flowers of a species at comparable stages of development are rather uniform, however, and, for this reason, the Chinese species may be divided into two distinct groups, the long-pedicellate and the short-pedicellate.

Species in the long-pedicellate group have pedicels 5 mm. or more long immediately before anthesis (FIG. 1). When the petals begin to open, the length of the pedicels has doubled (FIG. 2), and by the time the petals drop off, the pedicel is three times as long as that of a mature flower bud (FIG. 3). After anthesis the pedicel elongates slightly; therefore the fruiting pedicel of a species is longer than that of the flower.

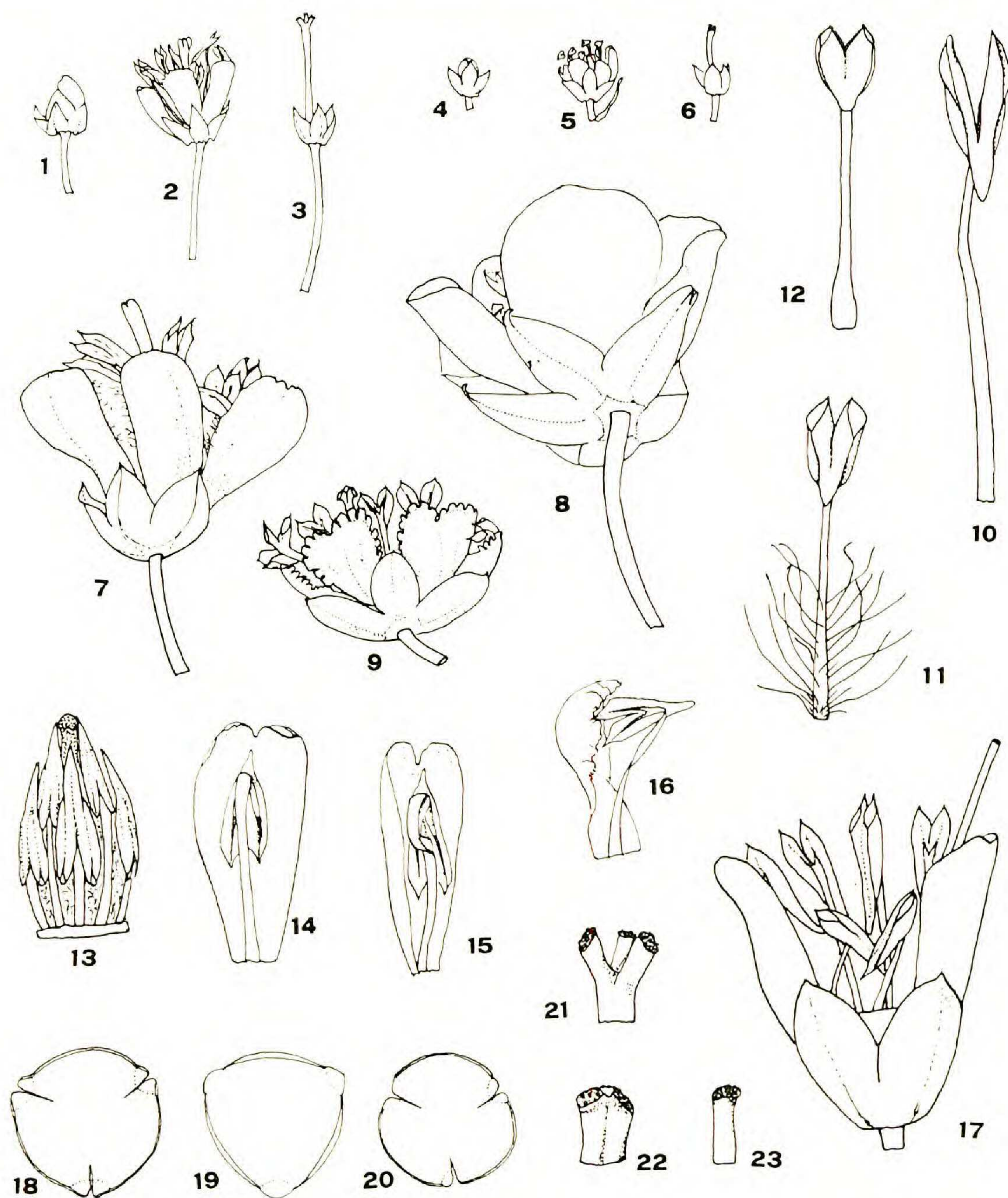
The pedicels of the short-pedicellate species are 1–2 mm. long immediately before anthesis (FIG. 4) and are normally shorter than the sepals. During anthesis, these pedicels elongate three-fold. As the sepals do not increase in size during this period, the length of the pedicels and that of the sepals are almost equal (FIGS. 5, 6).

The relative length of the pedicels and sepals is a reliable taxonomic character in *Clethra*. In employing this character one may use it only when the pedicels of the specimens are in comparable stages of development.

Calyx. The Chinese species of *Clethra* are distinctly gamosepalous. The calyx is essentially patelliform, deeply divided into 5 lobes. The short united portion is truncate and ridged at the basal end. The imbricate lobes vary in shape and size. The calyx attains mature size early in the development of the flower and maintains its shape and size during anthesis. Thus the calyx of a young flower bud and that of the young fruit of a species are about the same shape and size.

The calyces of the Chinese species of *Clethra* differ in the degree of division and in the shape and size of the lobes. The calyx of *C. bodinieri* is cut half way to the middle and its lobes are ovate, only 3 mm. long (FIG. 7). The calyx of *C. delavayi* is deeply cut with lanceolate lobes (FIG. 9) while the calyx of *C. kaipoensis* is deeply cut with oblong lobes (FIG. 8). The characters drawn from the calyx and sepals are reliable and are usually correlated with the length of the pedicel, the shape of the petals, and the relative length of the filaments. They can serve as good criteria for distinguishing sections and series.

Corolla. All the species of *Clethra* are choripetalous. Like the sepals, the petals of different Chinese species of *Clethra* can be grouped into three types. In *C. bodinieri* the petals are oblong, ciliate along the margin, ven-



FIGS. 1-23. MORPHOLOGICAL DETAILS OF CHINESE SPECIES OF CLETHRA.

FIGS. 1-6. Elongation of pedicels during anthesis, showing stages before, at, and after anthesis, $\times 1$: 1-3, a long-pedicellate species, *C. esquirolii* (Tsoong 83440); 4-6, a short-pedicellate species, *C. brammeriana* (Wang 247).

FIGS. 7-9. Calyces, $\times 3$: 7, shallowly divided calyx of *C. bodinieri* var. *parvifolia* (Tsang 22450) with ovate lobes; 8, deeply divided calyx of *C. delavayi* (Delavay 3319); 9, deeply divided calyx of *C. kaipoensis* (Tsang 27916) with oblong lobes.

FIGS. 10-12. Stamens, $\times 7$: 10, *C. cavaleriei* (Tsang 21413), stamen from rather large flower with exserted stamens—note glabrous filaments, V-shaped elongate anther, slim thecae, elongate rimiform apical pores, and long basal process; 11, *C. delavayi* (Forrest 11590), stamen from large flower with included stamens—note villous filament, oblong-obovate anther, rather plump thecae, broad apical pores, short basal process; 12, *C. brammeriana* (Wang 247), stamen from small flower with exserted stamens—note glabrous filament

trally barbate, and emarginate at the apex (FIG. 7). In *C. delavayi* the petals are large, almost entire, neither ciliate nor barbate, and are longer than the stamens (FIG. 8). In *C. faberi* and *C. kaipoensis* the petals are obovate, fringed, glabrous or slightly villose on the inside, and shorter than the stamens (FIG. 9). Petal characters, when correlated with characters of the pedicel, sepal, and stamen, can be used for distinguishing series.

Stamens. A flower of *Clethra* has ten stamens disposed in two whorls, the outer opposite the petals, and with shorter filaments (FIG. 13). In *C. bodinieri* the sepalad anthers are slightly longer. In *C. barbinervis* the difference in the size of the anthers is not appreciable.

The filaments of *Clethra* may be glabrous, hirsute, or villose. The indumentum of the filament has been used as a specific character. Before experimental evidence of the importance of hairs in the speciation of *Clethra* is available, this easily detected character is used for distinguishing species.

In the historical review we have noted that Hooker in 1876 gave a very accurate description of the stamens of *Clethra*. He pointed out that the anthers of this genus are obovate and the thecae dehisce above the middle by elongate pores. It appears now that in some widely accepted manuals and text books on the taxonomy of vascular plants published in recent years, different descriptions of the anthers and their dehiscence are given. Some of these statements give a rather incomplete picture, while others involve inaccurate observations. For example, Fernald in 1950 stated, "anthers extrorse in bud and opening by pores at base and inverted in flower" and Lawrence in 1951 noted, "anthers 2-celled, extrorse, sagittate, inverted and inflexed in bud, dehiscing by apical pores." The determination of the apex and base of an anther and the introrse or extrorse dehiscence of its thecae depends upon the attachment of the anther to the filament. The anther in *Clethra* is dorsifixed, often appearing versatile at

abruptly enlarged at base, very short obcordate anther, rather plump thecae, small apical pores.

FIGS. 13-16. Stages in maturation of stamens to show straightening of filaments in *C. cavaleriei* (H. H. Chung 2932), $\times 5$: 13, position of young anthers in half-grown bud, sepals and petals removed, anthers in an upside-down position, outer whorl of stamens with short filaments; 14, adaxial view of young stamen and petal, showing bend of filament below point of attachment; 15, same, at a later stage of development, showing knee-shaped bend produced by elongation of filament; 16, lateral view of stamen and petal at a more advanced stage, the filament almost straightened.

FIG. 17. Fully opened flower of *C. bodinieri* (Tsang 22450), showing short stamens of outer whorl and long stamens of inner whorl, some petals and stamens removed, $\times 5$.

FIGS. 18-20. Pollen grains of *C. delavayi*, *C. bodinieri*, and *C. faberi* respectively.

FIGS. 21-23. Style and stigma types, $\times 10$: 21, trifid style with three stigmas (*C. cavaleriei*); 22, undivided style with 3 apical lobes, 3 stigmas (*C. brammeriana*); 23, undivided style with single punctiform stigma (*C. bodinieri*).



FIGS. 24-27. Habit and inflorescence types of Chinese species of *Clethra*, $\times \frac{1}{2}$. 24, Flowering branchlets of *C. esquirolii* (Steward & Cheo 394), showing formation of vegetative shoots from active axillary buds; 25, Fruiting branchlet of *C. bodinieri* var. *parvifolia* (Tsang 23822), showing leaves on growth of two years; 26, *C. delavayi* (leaf, Delavay 3319; flowering branchlet, Forrest

anthesis. A mature anther is V-shaped (FIG. 10), obovate-oblong (FIG. 11), or obcordate (FIG. 12). The thecae dehisce by rimiform apical pores situated slightly on the ventral side of the anther.

In a flower bud, the inverted position of the anther is caused by the outward folding of the filament which occurs at a point about one-fifth below the attachment of the anther (FIGS. 13, 14). As the flower opens, the apical half of the filament increases in length several times faster than the basal half becoming geniculate in character (FIG. 15). The tension created by the elongating filament pushes the anther up (FIG. 16) and as the filament becomes straightened, the anther is set at its normal position with the apical pores pointing upward and inward (FIGS. 1-12, 17). In 1952 Kavaljian published on the floral morphology of *Clethra*, and regarding the inversion of the anther he stated, "the morphological base becomes the apparent apex." This statement is unnecessary because the rolling and folding of filaments in flower buds and the straightening of the filaments at anthesis are as common as the vernalization and the unfolding of leaves. They are normal processes of growth. In *Clethra* the change of position of the anthers from bud to fully grown flower occurs in the filaments, not at the points of attachment of the anthers to the filaments. Therefore, what Kavaljian termed the "apparent apices" of the anthers are the "morphological apices."

Because of the change of the length of the filament during the short period of anthesis, specimens collected at different stages in the development of the flower may have different appearances. For this reason the nature of the flower in regard to its included or exerted anthers is not a very satisfactory criterion for distinguishing species. It can be used only as an auxiliary character. Variations in the size and shape of the anthers of different species are obvious. The longest anthers, such as those found in *C. bodinieri* and *C. cavaleriei*, are 2.5-3 mm. long, V-shaped in outline, deeply parted above, with relatively slim thecae and elongated rimiform apical pores (FIG. 10). The medium-sized anthers, such as those found in *C. delavayi* and *C. monostachya*, are 1.75-2 mm. long, obovate-oblong in outline, moderately parted above, with rather plump thecae and short and wide apical pores (FIG. 11). The short anthers, such as those found in *C. kaipoensis* and *C. brammeriana*, are only 1 mm. long, obcordate in outline, shallowly parted above, the thecae short, plump and with small apical pores (FIG. 12). Anther characters correlate with the size of flowers and the shape and sizes of sepals and petals. They can be used as auxiliary characters for distinguishing sections or series.

Pollen grains of *C. delavayi*, *C. bodinieri* and *C. faberi* taken from herbarium specimens were examined. They differ in shape and structure in their apertures (FIGS. 18-20). The grains of *C. delavayi* and *C. faberi* are tricolporate. The grains of *C. faberi* lack the protruding roof of the ora which Erdtman considered to be a characteristic feature of the pol-

15889); 27, *C. fargesii* (Henry 7270), showing subumbelliform racemes, small vegetative shoots developed from active axillary buds.

len of the genus. The pollen of *C. bodinieri* seems to be porate and not colporate. The significance of pollen morphology in the taxonomy of infrageneric groups of *Clethra* awaits further research and judgment by competent palynologists.

Pistil. The pistil is tricarpellate. The ovary is always pubescent, while the style may be pubescent or glabrous, trifid or undivided at the apex. The presence or absence of hairs on the style has been used as a specific character, and this practice is adopted here. The trifid style has three terminal stigmas (FIG. 21). Most of the Chinese species of *Clethra* have trifid styles. The undivided style may have 3-lobed stigmas such as are found in *C. brammeriana* (FIG. 22), or it may have a single punctiform stigma such as is found in *C. bodinieri* (FIG. 23). The type of style and stigma may be used as an auxiliary character for distinguishing species in *Clethra*.

Fruits. The fruit is a loculicidal capsule with persistent sepals and style. The relative length of the fruiting pedicels is a helpful character for distinguishing species. There seems to be a positive correlation between the size of the flower and fruit of a species. The fruits of the large-flowered species *C. delavayi* are 4–6 mm. in diameter, while those of the small-flowered species *C. kaipoensis* are 2.5–3 mm. in diameter. Most of the herbarium specimens which I have examined lack fruits, and their significance in the classification of the species is not emphasized.

Seeds. Material with fully grown seeds is scarce in our herbaria. The seeds of *C. bodinieri*, *C. barbinervis*, *C. cavaleriei*, *C. delavayi* and *C. monostachya* were examined. Those of the first three species are irregularly angular, extremely reticulate and not winged. The seeds of *C. delavayi* and *C. monostachya* are slightly compressed, 1 mm. long, 0.5 mm. wide, reticulate and the cells along the margin are enlarged, but no wings are evident. The seeds of the Chinese *Clethra* are very different from the highly compressed and winged seeds of the North American species.

ECOLOGICAL NOTES AND GEOGRAPHICAL DISTRIBUTION

The Chinese species of *Clethra* are essentially mountainous forms. They occur in thickets or at the margin of woods in acid soil. The available material in our herbaria indicates that there are two distinct groups of species, the western and the eastern, which are separated by six hundred miles. No collection of *Clethra* has been recorded in the area in between.

The western species constitute a small series, *Delavayanae*, of high mountain forms. They usually occur at altitudes of 2400–3800 meters. *Clethra delavayi*, *C. yuiana*, and *C. monostachya* belong to this group. In *C. delavayi* a glabrous variety has been recorded from a higher altitude than the pubescent variety. In this western range, *C. monostachya* occurs in the North and *C. delavayi* and *C. yuiana* in the South (MAP 1).

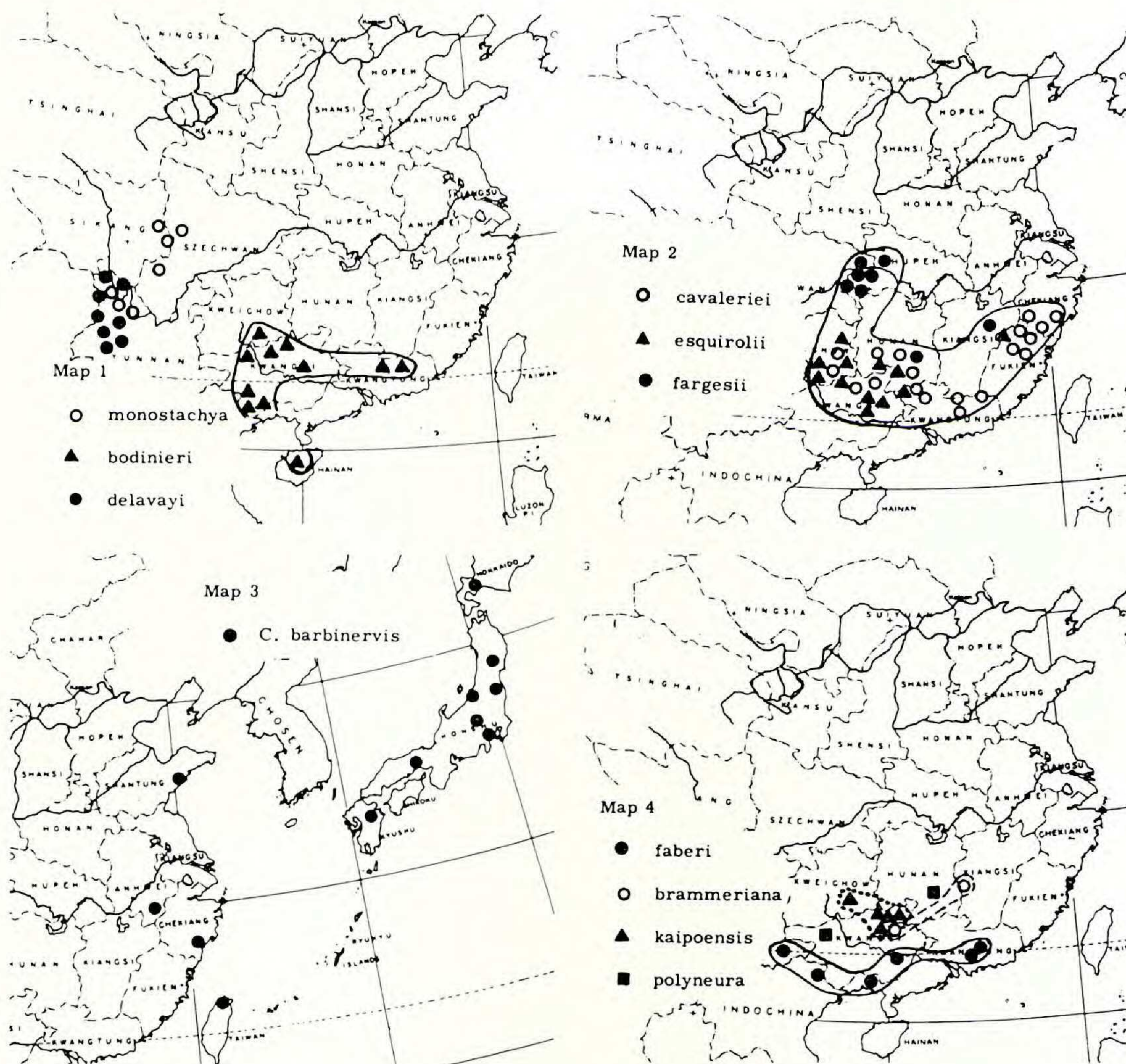
The eastern group involves a more heterogeneous assemblage of species.

The area covered by these species is at lower altitudes, the majority of the species occurring between 600 and 1000 meters above sea level. A couple of species may reach an altitude of 1250–1600 meters. *Clethra kaipoensis* has been collected at altitudes of 1000–2100 meters.

The distribution maps of different species involved in the eastern region indicate that the Nan-ling Range constitutes the center of the aggregation of species. This range represents a chain of much-dissected ancient hills and mountains extending along the Tropic of Cancer from the Yunnan-Kwangsi border, eastward to the Kweichow-Hunan-Kwangsi-Kwangtung borders, and then northeastward to the Kiangsi-Fukien-Chekiang borders.

Clethra bodinieri, the only species of section *Monostigma*, occurs principally on the southern flank of the Nan-ling Range, and from the western end, its range extends southward to Hainan (MAP 1).

The distributions of three closely related species, *C. cavaleriei*, *C. esquirolii* and *C. fargesii*, form a U-shaped pattern with the base falling over the Nan-ling Range, the left arm extending along the Kweichow-Hunan border northward to the Szechuan-Hupei border, and the right arm ex-



MAPS 1-4. Distribution of some Chinese species of *Clethra*.

tending along the Kiangsi-Fukien border northward to southern Chekiang (MAP 2). It is worthy of note that *C. fargesii* has its best development in the north on the western arm while *C. cavaleriei* is better developed in the north of the eastern arm.

MAP 3 shows the distribution of *C. barbinervis* in China and Japan. This species and *C. fargesii* are the eastern Asiatic representatives of series *Alnifoliae*. The other species of this series, *C. alnifolia* and *C. acuminata*, occur in eastern North America. The distribution of the species of *Clethra* in series *Alnifoliae* gives specific evidence to support the floristic relationship between the Lower Yangtze Region in China and eastern United States of America.

Clethra faberi is a unique species. In geographical distribution its range does not overlap that of any other Chinese species (MAP 4). In morphological characters it has the subcoriaceous leaves of the evergreen species in section *Monostigma*, the umbelliform-paniculate racemes and fringed petals of species in section *Cuellaria*, and the V-shaped anther of species in section *Clethra*. Evidently the distribution of *C. faberi* is on the northern periphery of the range of the series *Faberianae*. *Clethra petelotii* from Indochina, *C. lancifolia* from the Philippines, *C. canescens* from the Philippines, Borneo, and Celebes, and *C. ledermannii* from the western highlands of New Guinea are all related species.

The Chinese species of section *Cuellaria* are concentrated in a more limited area of the middle Nan-ling Range (MAP 4). It is noteworthy that all other species of this section are found in tropical America from Mexico to Brazil. In interpreting the distribution of the fresh-water fishes from tropical eastern Asia to the New World, Darlington in 1957 suggested that during different geological times, many kinds of fresh-water fishes evolved in the eastern Tethys region have radiated by way of the north temperate region to North and Central America. The distribution of *Clethra* in geological time probably followed the same direction.

Clethra is an Asiatic-American genus. It is evident that *C. arborea* Ait., the single species described from the Madeira Islands, is out of the natural range of the genus. A comparative study of all the material in the Gray Herbarium and the Arnold Arboretum reveals that *C. arborea* from the Madeira Islands is closely allied to *C. pulcherrima* of the east coast of Sumatra. The two species are alike in their arborescent habit, large, oblong-elliptic, pubescent leaves, paniculate racemes, large flowers, elongate petals, included stamens, hirsute filaments and V-shaped anthers. It is very clear that *C. arborea* is an introduction from the East Indies to the Madeira Islands in historical time. The small hairy capsules and the very minute seeds are adapted for attachment. It was probably accidentally introduced in connection with the spice trade, and was firmly established in the late eighteenth century when it first caught the attention of British naturalists. Both *C. pulcherrima* and *C. arborea* are closely related to *C. delavayi* of western China.

TAXONOMY

Clethra Linn. Sp. Pl. 396. 1753, Gen. Pl. ed. 5. 188. 1754; Benth. & Hook. f. Gen. Pl. 2: 603. 1876; Rehder, Bibl. Cult. Trees Shrubs 502. 1949.

TYPE SPECIES: *C. alnifolia* Linn.

Evergreen or deciduous trees or shrubs 1–18 m. high. Leaves alternate, simple, exstipulate, chartaceous, rarely coriaceous or subcoriaceous, obovate, oblong, rarely lanceolate, base cuneate, rarely acute or rounded, apex acuminate, margin serrate, rarely subentire. Flowers in simple, paniculate, or subumbelliform racemes, rachis and pedicels stellate-pubescent, rarely covered by simple, straight hairs; calyx patelliform, with broad-ovate to lanceolate lobes; corolla choripetalous, emarginate, erose or fringed; stamens 10, in two whorls, the outer whorl opposite the petals, filaments glabrous or hirsute, reflexed in bud, straightened at anthesis, anthers 4-celled in bud, at anthesis V-shaped, oblong-obovate or obcordate, connective extending into a basal sterile process, thecae opening by terminal rimiform pores; pollen grains simple, tricolporate or triporate; ovary superior, pubescent, 3-locular, style trifid or undivided, 3-lobed or not lobed; stigmas 3, rarely 1; ovules 20–40 in each locule, on axile placentas. Fruit a subglobose capsule with persistent calyx and style, loculicidal. Seeds small, ovoid and irregularly angular or dorso-ventrally compressed, the seed coat of one layer of cells, extremely reticulate, in some species wing-like; endosperm fleshy and oily. About 120 species with Asian-American distribution.

KEY TO THE SECTIONS, SERIES AND SPECIES

- A. Petals densely barbate on the inside; style undivided; stigma 1, punctiform; fruits globose, villose-hirsute; leaves evergreen; pollen triporate; hairs on the rachis and pedicels simple, gray, appressed. Sect. 1. MONOSTIGMA.
..... 1. *C. bodinieri*.
- A. Petals glabrous or sparsely villose at the base on the inside; style trifid or undivided, 3-lobed with 3 stigmas; leaves deciduous (except *C. smithiana*); pollen tricolporate; hairs on the rachis and pedicels stellate or tufted, hirsute, usually ferrugineous.
 - B. Anthers V-shaped or oblong-obovate; pedicels longer than the sepals at anthesis; petals emarginate, rarely fringed; racemes various. Sect. 2. CLETHRA.
 - C. Flowers large, the petals 8–10 mm. long; stamens included; filaments hirsute, the hairs white; anthers oblong-ovate; racemes solitary. Series A. DELAVAYANAE.
 - D. Style pubescent; petals papillose on the outside; leaves elliptic, attenuate at both ends, 6–14 cm. long, 2.5–5.5 cm. wide. 2. *C. monostachya*.
 - D. Style glabrous; petals smooth outside; leaves various in shape and size.
 - E. Leaves uniformly hispid above, pubescent beneath (except the

- glabrous variety), obovate or oblong. 7–23 cm. long, 3.5–9 cm. wide. 3. *C. delavayi*.
- E. Leaves glabrous above, inconspicuously appressed-pilose on the midrib and lateral nerves beneath, lanceolate, 10–15.5 cm. long, 3–4 cm. wide. 4. *C. yuiana*.
- C. Flowers small, the petals 4–6 mm. long; stamens exserted, the filaments glabrous or villose with ferrugineous or nigrescent hairs; racemes various.
- F. Racemes solitary; sepals ovate-lanceolate, 4–5 mm. long; petals emarginate; anthers V-shaped, 3 mm. long. Series B. ESQUIROLIANAE.
- G. Filaments glabrous; petals not glaucous; leaves oblong-elliptic, the base acute or obtuse. 5. *C. cavaleriei*.
- G. Filaments pubescent; basal half of the petals glaucous; leaves ovate-elliptic, the base obtuse or rounded. 6. *C. esquirolii*.
- F. Racemes paniculate or subumbelliform; sepals ovate-orbicular, 2–4 mm. long; petals more or less fringed. Series C. ALNIFOLIAE.
- H. Fruiting pedicels 2–3 times as long as the diameter of the capsules; leaves chartaceous.
- I. Filaments glabrous; leaves obovate or broad-elliptic, the base cuneate; racemes paniculate; sepals broad-ovate, 2–2.5 mm. long, obtuse. 7. *C. barbinervis*.
- I. Filaments pubescent; leaves ovate-oblong, the base obtuse; racemes subumbelliform; sepals lanceolate, 4–5 mm. long. 8. *C. fargesii*.
- H. Fruiting pedicels about as long as the diameter of the capsules; leaves subcoriaceous. Series D. FABERIANAE.
- 9. *C. faberi*.
- B. Anthers cordate; pedicels shorter than the sepals at anthesis; petals fringed; racemes subumbelliform. Sect. 3. CUELLARIA.
- J. Style pubescent near the base. 10. *C. pinfaensis*.
- J. Style glabrous.
- K. Leaves deciduous, distinctly serrate, elliptic or oblong, chartaceous, 11–20 cm. long; 5–7 cm. wide; petals glabrous.
- L. Primary lateral nerves parallel-arcuate, 6–10 mm. apart; hairs on the lower leaf-surface or nerves stellate.
- M. Filaments glabrous.
- N. Leaves stellate-hirsute on the nerves beneath, otherwise glabrous; margin sharply serrate. 11. *C. kaipoensis*.
- N. Leaves uniformly velvety beneath; margin subentire, minutely mucronulate-ciliate or serrate. 12. *C. brammeriana*.
- M. Filaments villose at the base. 13. *C. kwangsiensis*.
- L. Primary lateral nerves parallel, 4–6 mm. apart; hairs on the nerves beneath simple, appressed. 14. *C. polyneura*.
- K. Leaves evergreen, subentire or remotely serrate near the apex, linear-lanceolate, 7–13 cm. long, 2–3 cm. wide. 15. *C. smithiana*.

Section 1. MONOSTIGMA S. Y. Hu

Clethra, sect. **Monostigma**, sect. nov.

TYPE SPECIES: *C. bodinieri* Lévl.

Frutices sempervirentes ramulosis hornotinis pilosis; foliis coriaceis; racemis solitariis, rachibus pedicellisque pilosis; sepalis ovatis; petalis intus barbatis, filamentis hirsutis; stylis glabris, apice punctiformibus. One species, Kwangtung, Kwangsi, Hainan and Kweichow.

1. **Clethra bodinieri** Lévl. Repert. Sp. Nov. Fedde 10: 475. 1912; Hand.-Mazz. Sinensia 5: 3. 1934; Merr. & Chun, Sunyatsenia 5: 156. 1940.

var. **bodinieri**

An evergreen shrub, 2–5 m. high, the branchlets ascending, the current year's growth 2–3 mm. thick, inconspicuously pilose, the hairs simple. Leaves coriaceous, lanceolate, 5–9 cm. long, 1–2.5 cm. wide, base cuneate to acute, apex caudate-acuminate, the acumen 1.5–2 cm. long, glabrous above, inconspicuously pilose on the midrib beneath, angles of principal nerves slightly barbate; margin mucronate-denticulate, the basal half or one-third entire, lateral nerves 8, arcuate, obscure above, conspicuous beneath; petioles 5–12 mm. long, pilose. Racemes solitary, 3–13 cm. long, peduncles distinct, rachis pilose, the hairs simple, gray; pedicels 7–8 mm. long at anthesis; sepals ovate, 2.5–3 mm. long; petals oblong, 5 mm. long, 2.5 mm. wide, densely barbate inside; filaments hirsute; style glabrous, the stigma entire. Capsules globose, densely villose-hirsute; persistent style 7–9 mm. long; pedicels 10–12 mm. long. Seeds brown, 0.5–1 mm. long, angular-ovoid.

KWANGTUNG: *W. T. Tsang* 25451, 25620, 25828. KWANGSI: *R. C. Ching* 5695, 5734, 5804, 7181; *W. T. Tsang* 22450, 24023; *C. Wang* 39602.

Occurring in open thickets or woods at altitudes of 600–1600 meters; the white flowers with pinkish sepals and pedicels appear in June; a very distinct species with no close relationship to any other Chinese species of *Clethra*.

var. **latifolia**, var. nov.

Frutex sempervirens 4 m. altus, ramulis hornotinis incanis; foliis obovato-oblongis vel obovato-ellipticis, 7–9.5 cm. longis, 2.5–3 cm. latis, basi obtusis, apice acuminatis, acumine 5–10 mm. longo, margine serratis, supra glabris, subtus barbatis; racemis 6 cm. longis; filamentis dense villosis; stylo glabro.

HAINAN: Loktung, in dense woods, *S. K. Lau* 27312 (type, A), June 27, 1936 (shrub 4 m. high, leaves green above).

Occurring in dense woods; flowering in late June; distinguished from the typical *C. bodinieri* by its obovate-oblong leaves with obtuse bases.

var. *parvifolia*, var. nov.

Frutex 1.5–2.5 m. altus ramulis hornotinis sparse pilosis; foliis ellipticis, raro obovato-ellipticis, 3–5 cm. longis, 8–17 mm. latis, basi cuneatis et acutis, apice acuminatis, acumine 5–9 mm. longo, supra glabris, subtus barbatis aliter glabris; racemis 6–9 cm. longis; filamentis hirsutis; stylo glabro.

KWANGSI: Shang-sze District, fairly common, in thickets, dry steep slope, *W. T. Tsang* 22450 (type, A), June 2–7, 1933 (woody, 5 ft. high, flowers white, fragrant); *W. T. Tsang* 23822, 22456.

Occurring in thickets and woods; flowering in early June; distinguished from the typical *C. bodinieri* by its small leaves which seldom reach 5 cm. in length.

Section 2. CLETHRA

Clethra, sect. Clethra

Clethra sect. *Euclethra* DC. Prodr. 7: 588. 1839; Drude in Engler & Prantl, Pflanzenfam. IV. 1: 1. 1897.

TYPE SPECIES: *C. alnifolia* Linn.

Deciduous trees or shrubs, branchlets stellate-pilose. Leaves chartaceous, rarely subcoriaceous. Rachis and pedicels stellate-pilose; racemes solitary or paniculate or subumbelliform, pedicels elongate; sepals ovate to lanceolate; petals glabrous inside or rarely slightly pilose near the base; style trifid or undivided and 3-lobed at the apex, stigmas 3. About 15 species, eastern Asia and eastern North America. Subdivided into four series.

Series A. DELAVAYANAE S. Y. Hu

Clethra, sect. Clethra, series Delavayanae, ser. nov.

TYPE SPECIES: *C. delavayi* Franch.

Arbores vel frutices, foliis chartaceis, serrato-dentatis; racemis solitariis, pedicellis elongatis; staminibus inclusis, filamentis hirsutis; stylis trifidis; capsulis hispidis; seminibus dorso-ventralibus compressis. Three species in West China, the related species in Sumatra.

2. *Clethra monostachya* Rehder & Wilson in Sargent, Pl. Wils. 1: 501. 1913; Rehder, Man. 675. 1927, ed. 2. 690. 1940, Bibl. 502. 1949; Chen, Ill. Man. Chin. Trees Shrubs 942. 1937.

Clethra delavayi sensu Stapf in Bot. Mag. 148: t. 8970. 1923; sensu Rehder, Man. 675. 1927, ed. 2. 690. 1940, non Franchet.

A tall shrub or small tree, 2–8 m. high. Leaves elliptic, or ovate-elliptic, rarely lanceolate, 7–13 cm. long, 2.5–5.5 cm. wide, base cuneate, apex acuminate, acumen 1–1.5 cm. long, apiculate, margin sharply serrate,

primary lateral nerves 16–21 pairs, both surfaces glabrous, the large nerves slightly pilose and their angles barbate beneath; petioles 1–2.5 cm. long, inconspicuously stellate-pilose in the grooves above; leaves produced by active lateral buds lanceolate, 4–6.5 cm. long, 1.3–2 cm. wide, both surfaces subglabrous, the nerves and their angles pilose beneath. Racemes solitary, 7–18 cm. long, the rachis densely ferrugineous-hirsute, the hairs tufted; pedicels 6–10 mm. long at anthesis; sepals 4–5 mm. long, acute; petals 5–6 mm. long, papillose outside; filaments hirsute; style pubescent, apex 3-cleft. Capsules subglobose, 4 mm. in diameter; pedicels 15–18 mm. long; persistent style 7–8 mm. long.

YUNNAN: *R. C. Ching* 21452; *M. K. Li* 2079; *T. T. Yu* 17303. SIKANG (Szechuan on labels): Tien-chuan, *Y. S. Liu* 1329; Han-Yuen, Ta Hsiang Ling, *C. Y. Chiao* 1616; Moupin, *E. H. Wilson* 1192 (paratype). West China, without precise locality, *E. H. Wilson*, Veitch Exp. 3927 (type).

Occurring on the margins of woods and thickets at altitudes of 1700–2800 meters in the mountains of the Yunnan-Szechuan-Sikang borders; a very distinct species closely related to *C. delavayi*; distinguished by its elliptic leaves attenuate at both ends, smaller flowers, papillose petals, pubescent filaments and styles.

The specimens from Yunnan are not typical. The stamens are enclosed, as in *C. delavayi*. The material illustrated by Stapf has pilose styles, and it apparently belongs here. Rehder's account in his *Manual* is based on Stapf's illustration. The isotype of *C. delavayi* has glabrous styles.

3. ***Clethra delavayi*** Franchet, Jour. de Bot. 9: 370. 1895; P. Dop, Bull. Soc. Bot. France 75: 731. 1928; Rehder, Man. 675. 1927, ed. 2. 690. 1940. Bibl. 502. 1949; Chen, Ill. Man. Chin. Trees Shrubs 942. 1937; Merr. in Brittonia 4: 137. 1941.

var. *delavayi*

A tall shrub or small tree 4–5 m. tall, the current year's growth densely stellate-hispid, 3–6 mm. thick. Leaves obovate or elliptic-oblong, 7–15 cm. long, 3.5–6 cm. wide, base cuneate, apex acuminate or acute, the acumen 5–10 mm. long, uniformly hispid above, tomentose beneath, margin serrate, lateral nerves 20 or 21 pairs; petioles 10–17, densely villose; axillary buds more or less stalked, usually bearing no leaves, the stalk 3–40 mm. long. Racemes solitary, 18–25 cm. long, the rachis densely ferrugineous-hispid, the hairs tufted; pedicels 6–7 mm. long at anthesis; sepals ovate-lanceolate, 5–6 mm. long; petals oblong-obovate, 10 mm. long, 5 mm. wide, apex emarginate, ciliate; filament hirsute at the base, the hairs white; style glabrous, the apex trifid. Capsules subglobose, 4 mm. in diameter; persistent style 6–7 mm. long; pedicels 14–20 mm. long.

YUNNAN: *Delavay* 3319 (isotype); *G. Forrest* 11590, 15528, 15839, 17545; *McLaren* (*C Collector* 237); *H. T. Tsai* 58408; *T. T. Yu* 20979.

Occurring in mixed forest at altitudes of 2400–3200 meters; a very distinct species, closely related to *C. monostachya*, distinguished by its obovate leaves which are uniformly tomentose beneath, large flowers with enclosed anthers, hispid filaments, and glabrous styles.

var. lanata, var. nov.

Arbor parva 4 m. alta; foliis obovatis vel oblongo-ellipticis, 11–12 cm. longis, 3.5–5.5 cm. latis, supra hispidis, subtus dense lanatis; pedicellis fructuum 1.5–2 cm. longis.

YUNNAN: Che-tse-lo, Pi-lo-shan, alt. 4000 m., *H. T. Tsai* 58263 (type, A), August 27, 1934 (tree, flower white); *H. T. Tsai* 58459.

This variety occurs in the forest of Che-tse-lo of western Yunnan. The dense-lanate lower leaf-surface is very distinctive.

var. glabra, var. nov.

Arbor parva 3–5 m. alta; foliis oblongo-ellipticis vel obovato-oblongis, 13–23 cm. longis, 5.5–9 cm. latis, supra glabris, subtus glabrescentibus, ad costam et nervos lateralibus sparse pilosis; pedicellis florum 8–15 mm longis.

YUNNAN: *R. C. Ching* 20478, 22107; *K. M. Feng* 3301; *G. Forrest* 8875; *McLaren* (*D Collector* 130); *J. F. Rock* 17111, 18461; *H. T. Tsai* 59905, 59951; *C. W. Wang* 63886, 68702; Wei-Hsi, Mount Shang-Ma-Kou, alt. 3400 m., *J. F. Rock* 17174 (type, A), August 1928 (tree, 3–5 m. high, flowers white).

Occurring in mixed forests by streams at altitudes of 2800–3800 meters; the white flowers open in August; distinguished by its leaves which are glabrous above and pilose beneath on the principal nerves only.

4. Clethra yuiana, sp. nov.

Arbor 7–10 m. alta, ramulis herminis 4 mm. diametro, glabrescentibus; foliis lanceolatis, 10–15.5 cm. longis, 3–4 cm. latis, utrinque acuminatis, acumine 1 cm. longo, margine mucronato-serratis, supra glabris; subtus ad nervos primarios et costam pilosis, aliter glabris, nervis lateralibus utrinque 22–24, foliis ramulorum axillarium ellipticis vel lanceolatis, 1.5–2.5 cm. longis, 6–8 mm. latis, utrinque praesertim ad nervos pilosis; racemis solitariis, 22 cm. longis, densifloribus; rachibus stellato-pilosis, pilis brevibus; pedicellis florum 8–10 mm. longis; sepalis ovato-lanceolatis 5–6 mm. longis; petalis obovatis, 8 mm. longis, 5–6 mm. latis, apice emarginatis, utrinque glabris; filamentis hirsutis; stylis glabris, apice trifidis; capsulis ignotis.

YUNNAN: Shunning, Hila, Wumulung, alt. 2750 m., among forest, common, *T. T. Yu* 1720 (type, A), July 13, 1938 (tree, 20–30 ft. high, flowers white).

Occurring frequently in mixed forest at an altitude of 2750 meters; flowering in mid-July; closely related to *C. monostachya*, but distinguished by its larger flowers and glabrous styles.

Series B. ESQUIROLIANAE S. Y. Hu

Clethra, sect. **Clethra**, series **Esquirolianae**, ser. nov.

TYPE SPECIES: *C. esquirolii* Lév.

Frutices foliis ellipticis vel ovato-ellipticis, chartaceis, arguto-serratis; racemis solitariis, pedicellis elongatis; sepalis lanceolatis, staminibus exsertis, antheris V-formibus, elongatis; seminibus ovoideo-polygonis. Two species, southeastern China.

5. **Clethra cavaleriei** Lév. Repert. Sp. Nov. Fedde 10: 476. 1912; Rehder, Jour. Arnold Arb. 15: 267. 1934; Hand.-Mazz. Beih. Bot. Centralbl. 56B: 449. 1937.

Clethra lineata Lév. Repert. Sp. Nov. Fedde 12: 534. 1913.

Clethra longebracteata Sleumer, *ibid.* 38: 205. 1935.

Clethra sinica Hao, *ibid.* 42: 85. 1937.

A shrub or small tree 1–5 m. high, the current year's growth densely pilose, the hairs short-stellate. Leaves elliptic, 6–10 cm. long, 1.5–4 cm. wide, base acute, apex acute or shortly acuminate, glabrous above, very sparsely pilose on the principal nerves beneath, margin serrate, lateral nerves 12 or 13 pairs, reticulations of veinlets distinct beneath; petioles 1–1.5 cm. long, appressed pilose and glabrescent; leaves produced by active axillary buds lanceolate, 2–7 cm. long, 1–1.5 cm. wide, both surfaces sparsely stellate-pilose. Racemes solitary, 9–15 cm. long, bracts longer than the pedicels; pedicels 7–10 mm. long at anthesis; sepals lanceolate, 5 mm. long; petals 6 mm. long; filaments glabrous; style glabrous, the apex trifid. Capsules subglobose, 4–5 mm. in diameter; persistent style 9 mm. long; pedicels 14–15 mm. long.

FUKIEN: *R. C. Ching* 2250, 2300; *H. M. Fan* 9474, 9493, 9515; *H. H. Chung* 2923. KWANGTUNG: *R. Mell* 883; *W. T. Tsang* 21413, 21661. KWANGSI: *S. K. Lau* 28753, 28755. CHEKIANG: *R. C. Ching* 2101; *Y. L. Keng* 164 (isosyntype of *C. sinica*), 175 (isotype of *C. longebracteata*). KWEICHOW: *J. Cavalerie* 5 (fragment and photo of type); *J. Esquirol* 3238 (photo and fragment of type of *C. lineata*); *Handel-Mazzetti* 172 = 10557. HUNAN: *Fan & Li* 253.

Occurring in woods and thickets at altitudes of 780–1250 m.; flowering in August; closely related to *C. esquirolii*, distinguished by its glabrous filaments.

6. **Clethra esquirolii** Lév. Repert. Sp. Nov. Fedde 10: 475. 1912.

Clethra cavaleriei sensu Rehder, Jour. Arnold Arb. 15: 267. 1934, p.p.; sensu Hand.-Mazz. Symb. Sin. 7: 760. 1936, p.p., non Lév.

A shrub 1–3 m. high, current year's growth sparsely stellate-pilose, 3–4 mm. in diameter, subterete or angular. Leaves ovate-elliptic or elliptic, 6.5–10 cm. long, 2.5–4.5 cm. wide, base obtuse or rounded, apex short-acuminate, the acumen 1 cm. long, glabrous above, the nerves sparsely pilose and their angles slightly barbate beneath, margin serrate.

lateral nerves 10–12 pairs; petioles 1–2 cm. long, hirsute, straight and stellate hairs intermixed; leaves produced on active axillary buds elliptic, 3–4.5 cm. long, 12–15 mm. wide, both surfaces stellate-pilose, the midrib and lateral nerves lanate beneath. Racemes solitary, 10–16 cm. long, the rachis ferrugineously stellate-hirsute; pedicels 9–11 mm. long at anthesis; sepals ovate-lanceolate, 4–5 mm. long; petals oblong, 6–7 mm. long, 3–4 mm. wide, sparsely villose inside, basal half glaucous outside; filaments villose, the hairs ferrugineous or nigrescent; style glabrous, trifid at the apex. Capsules subglobose, 4 mm. in diameter; pedicels 1.5–2 cm. long; persistent style 9–12 mm. long.

FUKIEN: *R. C. Ching* 2300. KWANGTUNG: Lokchong, *Y. Tsiang* 1422. KWANGSI: Ling-Chuan, *W. T. Tsang* 27871; Tzu-yuen, *T. S. Tsoong* (= *Z. S. Chung*) 83440; *C. Wang* 39565, 40068. HUNAN: Sinning, *Fan & Li* 453; Wu-kang, *Handel-Mazzetti* 842 = 12397. HUPEI: *A. Henry* 2838. KWEICHOW: *J. Cavalerie*, July 19, 1898; *J. Cavalerie* 69 (*E. Bodinier*); *J. Esquirol* 651 (type, fragment and photo); *Steward, Chiao & Cheo* 394; *Y. Tsiang* 5460.

Occurring in open ridges or ravines of the Nan-ling Range, its range extending from northern Kwangsi and Kweichow, eastward through Hunan to northern Kwangtung and northern Fukien, and northward to western Hupei; closely related to *C. cavaleriei*, distinguished by its ovate or ovate-elliptic leaves with obtuse or rounded base, its glaucous petals and pubescent filaments.

Rehder and Handel-Mazzetti both interpreted this species as synonymous with *C. cavaleriei*. The fragment of the type of *C. esquirolii* and *Handel-Mazzetti* 12397 both have pubescent filaments. In this respect, they are different from the type of *C. cavaleriei*. *Clethra esquirolii* is distinguished from *C. fargesii* by its larger flowers and solitary racemes.

Series C. ALNIFOLIAE S. Y. Hu

Clethra sect. **Clethra**, series **Alnifoliae**, ser. nov.

TYPE SPECIES: *C. alnifolia* L.

Frutices foliis chartaceis, obovatis vel lato-ellipticis, crasso-serratis; racemis paniculatis; staminibus exsertis, antheris V-formibus; seminibus polygonis vel compressis. Five species, eastern United States of America and the Lower Yangtze Region of China.

7. **Clethra barbinervis** Sieb. & Zucc. Abh. Phys.-Math. Cl. Akad. Wiss. München IV. 3: 128. 1846; Gilg, Bot. Jahrb. Engler 34(Beibl. 75): 56. 1904; Loes. in Beih. Bot. Centralbl. 37(2): 164. 1919; Rehder, Man. 1927, ed. 2. 690. 1940, Bibl. 502. 1949; Kai, Pl. Sin. Ill. 306. fig. 538. 1937.

A shrub up to 10 m. high, the current year's growth 3–4 mm. thick, subglabrescent or minutely stellate-pilose. Leaves obovate-elliptic, 7–14 cm. long, 3–6.5 cm. wide, base cuneate and acute, apex abruptly short-

acuminate, the acumen deltoid, 5–10 mm. long, glabrous above, midrib and principal nerves hirsute and their angles barbate beneath, the hairs simple; margin sharp-serrate; lateral nerves 12–14 pairs, arcuate; petioles 1–2.5 cm. long, pilose, the hair appressed; leaves produced by active axillary buds obovate, 3.5–6.5 cm. long, 1.5–2.5 cm. wide, sparsely stellate-pilose above, sparsely villose beneath, straight and stellate hairs intermixed. Racemes 3–6, paniculate, the rachis densely ferrugineous-hispid, the hairs tufted; pedicels 4–6 mm. long at anthesis; sepals sub-orbicular-ovate, 2–2.5 mm. long; petals obovate, 5–6 mm. long, 3–4 mm. wide; apex emarginate, and fringed; filaments glabrous; style glabrous, the apex trifid. Capsules subglobose, 4 mm. in diameter; persistent style 6–8 mm. long; pedicel 6–8 mm. long.

TAIWAN: *R. Kanehira*, Sept. 5, 1920. CHEKIANG: *R. C. Ching* 1642. ANHWEI: *R. C. Ching* 3237, 3277. SHANTUNG: Tsingtao, *Zimmermann* 432.

Occurring in thickets on open hills at an altitude of 1000 meters; related to *C. faberi* and *C. fargesii* through its paniculate inflorescences, short sepals, and fringed petals; distinguished from *C. faberi* by its obovate leaves and elongate pedicels and from *C. fargesii* by its glabrous filaments and obovate leaves cuneate at the base. Kanehira and Zimmermann's collections are out of the normal range of the species. Probably these collections were made from cultivated plants. This species is common in Japan, and it is most likely that this species was introduced into Tsingtao and Taiwan from Japan.

8. *Clethra fargesii* Franch. Jour. de Bot. 9: 369. 1895; Rehder & Wilson in Sargent, Pl. Wils. 1: 502. 1913; Rehder, Man. 674. 1927, ed. 2, 690. 1940, Bibl. 502. 1949; Chen, Ill. Man. Chin. Trees Shrubs 942. fig. 835. 1937.

Clethra canescens sensu Forbes & Hemsl. Jour. Linn. Soc. Bot. 26: 33. (Ind. Fl. Sin. II). 1889, non Reinw. ex Blume.

Clethra sleumeriana Hao, Repert. Sp. Nov. Fedde 42: 84. 1937.

A tall shrub up to 4 m. high, the current year's growth densely stellate-pilose, 3–5 mm. thick. Leaves ovate-elliptic, 7–14 cm. long, 3–5 cm. wide, base obtuse or rotundate, apex acuminate, the acumen 1–2 cm. long, glabrous above, along the midrib and the principal nerves stellate-villose and their angles barbate beneath, lateral nerves 16–17 pairs, arcuate; margin mucronate serrate; petioles 14–17 mm. long, sparsely stellate pilose; leaves produced by the active axillary buds lanceolate, 4–10 cm. long, 1.5–3.3 cm. wide, both sides stellate pubescent. Racemes 3–7, subumbelliform-paniculate, the rachis densely brown-hirsute, the hairs tufted; pedicels 6–10 mm. long at anthesis; sepals lanceolate, 4–5 mm. long; petals obovate, 5–6 mm. long; filaments hirsute near the base; style glabrous, the apex trifid. Capsules subglobose, 3 mm. in diameter; persistent style 5 mm. long; pedicels 12–13 mm. long.

KIANGSI: *H. H. Hu* 1320. HUPEI: *Cheng & Hwa* 821, 1068, 1110; *H. C.*

Chow 885, 1178; *W. Y. Chun* 3714, 3734; *A. Henry* 5818, 6407, 7220; *E. H. Wilson* (Veitch Exp.) 1326, 2222. HUNAN: *S. S. Sin* 615 (type of *C. sleumeriana* Hao, not seen). SZECHUAN: *Farges* 108 (type, not seen).

Common in open woodlands and thickets in the middle Yangtze Region; closely related to *C. esquirolii*, but distinguished by its umbelliform-paniculate racemes, smaller flowers and densely stellate-pubescent branchlets.

Series D. FABERIANAE S. Y. Hu

Clethra, sect. **Clethra**, series **Faberianae**, ser. nov.

TYPE SPECIES: *C. faberi* Hance.

Frutices foliis subcoriaceis, subglabris vel subtus stellato-pilosis, canescentibus, serratis; racemis subumbelliformibus, pedicellis brevibus; petalis fimbriatis. About 10 species, China, Indo-China, the Philippines, Borneo, Celebes and New Guinea.

9. **Clethra faberi** Hance, Jour. Bot. Brit. For. 21: 130. 1838, "*fabri*"; Merr. Philipp. Jour. Sci. Bot. 13: 154. 1918; P. Dop, Bull. Soc. Bot. France 75: 732. 1928.

Clethra canescens sensu Forbes & Hemsl. Jour. Linn. Soc. Bot. 26: 33. (Ind. Fl. Sin. II). 1889, p.p.; sensu Dunn & Tutcher, Kew Bull. Add. Ser. 10: 155. (Fl. Kwangt. Hongk.) 1912, non Reinw.

Clethra liangii Li, Jour. Arnold Arb. 24: 449. 1943.

A deciduous shrub 2–2.5 m. high, the current year's growth sparsely pilose or glabrescent, 3 mm. in diameter. Leaves subcoriaceous, elliptic, or obovate-elliptic, rarely oblanceolate, 6–11 cm. long, 2–3.2 cm. wide, base acute, apex acuminate, the acumen 1 cm. long, margin sharply serrate, primary lateral nerves 10 or 11 pairs, parallel-arcuate, 6–8 mm. apart, impressed above, reticulations of the veinlets distinct beneath, lamina glabrous on both surfaces, on the principal nerves very sparsely pilose beneath; petioles 6–8 mm. long, sparsely stellate pilose; leaves produced by active axillary buds elliptic, 2.5–8 cm. long, 1–2.5 cm. wide, glossy, glabrous above, hispid on the nerves beneath. Racemes 2–7, paniculate, rarely on weak branchlets solitary, densely and ferrugineously caespitose-hirsute; many bracts persistent; pedicels 3–4 mm. long; sepals suborbicular-ovate, 2.5–3 mm. long, apex obtuse, mucronate; petals 4 mm. long, 2 mm. wide, inside sparsely villose below the middle; filaments glabrous, anthers acute at the base, divergent at the apex; style glabrous, 4 mm. long after anthesis, the apex subcapitate, lobed or shallowly cleft. Capsules 2.5 mm. in diameter.

KWANGTUNG: *C. Ford* 56; *W. T. Tsang* 26761. KWANGSI: *H. Y. Liang* 69645 (type of *C. liangii*); *S. P. Ko* 55527. YUNNAN: *H. T. Tsai* 60876.

Occurring in densely shaded forest or on open, grassy slopes at altitudes of 970–1100 meters; the white flowers appearing in late July and early

August; a very distinct species. Its short, obtuse sepals suggest a relationship with *C. barbinervis*, but its short pedicels, subcoriaceous leaves and small anthers are very different. The isosyntypes of *C. annamensis* P. Dop (*M. Poilane* 7519, 7616) apparently belong here.

Section 3. CUELLARIA (Ruiz & Pav.) DC.

Clethra, sect. **Cuellaria** (Ruiz & Pav.) DC. Prodr. 7: 589. 1839.

Cuellaria Ruiz & Pav. Fl. Per. Chil. Prodr. 59. t. 10. 1794, Syst. Veg. 103. 1798.

TYPE SPECIES: *C. ferruginea* Ruiz & Pav.

Trees or shrubs, branchlets densely stellate-pubescent. Leaves coriaceous or chartaceous. Rachis and pedicels densely ferrugineous-stellate-pubescent; racemes paniculate or subumbelliform, pedicels very short; sepals oblong or ovate; petals erose or fimbriate; stamens exserted or included. Seeds winged, or polygonous. About 85 species, chiefly in tropical America, 4 in China.

10. **Clethra pinfaensis** Lévl. Repert. Sp. Nov. Fedde 10: 476. 1912.

Clethra kaipoensis sensu Rehder, Jour. Arnold Arb. 15: 268. 1934; sensu Hand.-Mazz. Symb. Sin. 7: 760. 1926, non Lévl.

A tree up to 13 m. high, the trunk 30 cm. in diameter, the bark smooth, brownish. Leaves oblong-elliptic, 8–15 cm. long, 3–5 cm. wide, base obtuse, apex acuminate, the acumen 1.5–2 cm. long, margin sharp-serrate; primary lateral nerves 14 or 15 pairs, parallel-arcuate, glabrous above, glabrescent beneath, the hairs on the nerves beneath simple, appressed; petioles 8–20 mm. long; leaves produced by active axillary buds 3–7.5 cm. long, 1.5–2.5 cm. wide, sparsely stellate-pubescent above. Racemes 4–6, subumbellate, 14–18 cm. long, rarely shorter, densely ferrugineous-hirsute, the hairs tufted; pedicels 2–3 mm. long at anthesis; sepals ovate, 2–3 mm. long; petals 4 mm. long, 2 mm. wide; filaments glabrous; style pubescent at the basal end. Capsules 3 mm. in diameter; fruiting pedicels 4 mm. long; persistent style 5–6 mm. long, the stigma trifid. Seeds varying in size and shape, compressed ovoid, triangular, or subcylindric, 1–1.5 mm. long, 0.5–1 mm. wide, reticulate, brownish.

KWANGSI: *R. C. Ching* 6026, 7000, 7116. KWEICHOW: *J. Cavalerie* 346 (photo and fragment of type); *Handel-Mazzetti* 254 = 10766, 325 = 10997.

Occurring in woods at altitudes of 1300–1500 meters; flowering in late July and early August; closely related to *C. kaipoensis*, but distinguished by its styles being pubescent near the base. The style-character is clear in the fragment of the type. When Rehder and Handel-Mazzetti interpreted *C. pinfaensis* and *C. kaipoensis* as conspecific, they ignored this distinct character.

11. *Clethra kaipoensis* Lévl. Repert. Sp. Nov. Fedde 10: 475. 1912; Rehder, Jour. Arnold Arb. 15: 268. 1934, p.p.

A deciduous shrub 1–3 m. high. Leaves oblong-elliptic, 13–19 cm. long, 4–9 cm. wide, base obtuse or rotund, apex acuminate, the acumen 2 cm. long, margin coarse- and sharp-serrate, primary lateral nerves 16–18, 7–13 mm. apart, glabrescent above, sparsely stellate-pubescent along the nerves and barbate in their angles beneath; petioles 1.5–2.5 cm. long, densely ferrugineous-hirsute; leaves produced by the active axillary buds broad elliptic, 3–4 cm. long, 1.5–2 cm. wide, densely velvety on both surfaces, the hairs stellate. Racemes 4–8, subumbellate, occasionally solitary on weak branchlets, densely golden villose-hirsute; pedicels 3 mm. long; sepals deltoid-ovate, 3–4 mm. long; petals 4–5 mm. long; filaments glabrous, anthers 1.5 mm. long, base obtuse; style glabrous, the apex slightly enlarged, 3-lobed, after anthesis 5–6 mm. long. Capsule 4 mm. in diameter.

KWANGSI: *Steward & Cheo* 958; *Y. W. Taam* 24; *W. T. Tsang* 27900, 27916, 28425. KWEICHOW: *J. Cavalerie* 1221 (holotype, photo and fragment).

Occurring in forest at altitudes of 1000–2100 meters in Kweichow and northern Kwangsi; closely related to *C. kwangsiensis*; distinguished by its unusually large leaves and its glabrous filaments.

12. *Clethra brammeriana* Hand.-Mazz. Anzeig. Akad. Wiss. Wien Math.-Nat. Kl. 58: 151. 1921, Symb. Sin. 761. 1936.

A deciduous tree, the branchlets densely ferrugineous-hirsute, the hairs tufted, current year's growth 5 mm. in diameter. Leaves oblong-elliptic or obovate-oblong, 11–15 cm. long, 4.5–8 cm. wide, base obtuse or rotundate, apex acute or shortly acuminate, margin subentire and minutely mucronulate-ciliate or aristate-serrate, glabrous above, evenly velvety beneath, primary lateral nerves 15 or 16, parallel-arcuate, 8–12 mm. apart; petioles 14–18 mm. long, ferrugineously or castaneously hirsute. Racemes 5–13, subumbelliform-paniculate, 10–18 cm. long, densely and ferrugineously lanate-hirsute, some bracts persistent; pedicels 2 mm. long, sepals ovate-deltoid, 3–5 mm. long; petals 4 mm. long, 2.5 mm. wide; filaments glabrous, anthers obcordate, exserted; style 5 mm. long after anthesis, the apex undivided, 3-lobed. Fruit and seed not known.

KIANGSI: *T. H. Wang* 247 (isotype). KWANGSI: *T. S. Tsoong* (= *Z. S. Chung*) 83414.

Occurring in woods along ravines at an altitude of 600 meters; closely related to *C. kaipoensis*, but distinguished by its uniformly velvety lower leaf-surfaces. The flowers of *Tsoong* 83414, collected on July 15, are in very young bud.

13. *Clethra kwangsiensis*, sp. nov.

Arbor, ramulis hornotinis teretibus, 5 mm. diametro, dense ferrugineo-

pubescentibus pilis stellatis; foliis chartaceis, ovato-ellipticis, 16–17 cm. longis, 6–7.5 cm. latis, basi rotundatis vel obtusis, apice acuminatis, acumine 2 cm. longis, margine serratis, nervis lateralibus utrinque 20, arcuatis, supra glabris, subtus sparse stellato-pilosis, ad nervis villosis; petiolo 1.5 cm. longo, dense hirsuto; foliis ramulorum axillarium breviter ellipticis, 5–5.9 cm. longis, 3 cm. latis, utrinque stellato-tomentosis, pilis supra rigidis; racemis 6, subumbelliformi-paniculatis, 15–17 cm. longis, dense ferrugineis, pilis stellatis; pedicellis 2–4 mm. longis; sepalis deltoideo-ovatis, 3.5–4 mm. longis, acutis; petalis 5 mm. longis, 2 mm. latis, fimbriatis; filamentis villosis; stylo glabro, apice trifido; capsulis ignotis.

KWANGSI: Tzu Yuen District, in woods near a stream, *T. S. Tsoong* (= *Z. S. Chung*) 83570 (type, A), August 6, 1937 (tree, flowers white).

Occurring in woods along a stream; the white flowers appearing in early August; closely related to *C. kaipoensis*, but distinguished by its filaments being villose on the basal half.

14. *Clethra polyneura* Li, Jour. Arnold Arb. 24: 449. 1943.

Trees up to 18 meters high. Leaves oblong-lanceolate or oblong-elliptic, 9–15 cm. long, 3–6 cm. wide, base obtuse or rotund, apex acuminate, the acumen 1–2 cm. long, margin densely serrate, principal lateral nerves 18–25 pairs, parallel, 4–6 mm. apart, glabrous above, glabrescent beneath, the midrib and primary nerves sparsely pilose, the hairs simple and appressed; petioles 1–2.5 cm. long, sparsely stellate-hirsute; leaves produced by active axillary buds lanceolate, 4–7 cm. long, 1.3–2 cm. wide, sparsely stellate above, only the nerves ferrugineously stellate-pubescent beneath. Racemes 6–8, subumbellate-paniculate, 10–14 cm. long, densely ferrugineous-hirsute, the hairs tufted; pedicels 1.5–2 mm. long at anthesis; sepals ovate, acute, 2–3 mm. long; petals 3 mm. long, 1.75 mm. wide; filaments glabrous; style glabrous. Capsules 3 mm. in diameter, pericarp velvety; persistent style 6 mm. long, glabrous; fruiting pedicels 3–4 mm. long. Seed ovoid, reticulate, 1 mm. long, 0.5 mm. wide.

KWANGSI: *S. K. Lau* 28767 (type). HUNAN: *Fan & Li* 519.

Occurring on hilly slopes at altitudes of 650 m.; closely related to *C. kaipoensis*, but distinguished by its glabrous style and numerous parallel lateral nerves.

15. *Clethra smithiana* Fang, Contr. Biol. Lab. Sci. Soc. China. Bot. Ser. 12: 121. 1939.

An evergreen shrub or small tree 6–8 m. high, branchlets glabrous, the current year's growth 3–4 mm. in diameter. Leaves coriaceous, lanceolate, 7–13 cm. long, 2–3.5 cm. wide, base cuneate, apex acuminate, the acumen 1–2 cm. long, lateral nerves 15–17 pairs, arcuate, 8–13 mm. apart, obscure above, reticulations of veinlets conspicuous beneath; margin subentire, the apical half remotely sharp-serrate, both surfaces glabrous, the

principal nerves very sparsely pilose beneath; petioles 10–15 mm. long, sparsely pilose. Racemes 2–8, subumbelliform, 8–12 cm. long, densely castaneous-hirsute, the hairs tufted; pedicels 1.5–2 mm. long; sepals ovate, 2 mm. long, obtuse or acute; petals 2.5–3 mm. long, 1.5 mm. wide; filaments glabrous, apex of the anthers divergent; style undivided, 3 mm. long after anthesis, the apex slightly enlarged, lobate. Fruit 3 mm. in diameter.

KWANGSI: *R. C. Ching* 6854, 7209. YUNNAN: *H. T. Tsai* 51447 (type, not seen).

Occurring in woods at altitudes of 1130–1600 m.; a very distinct species, closely related to *C. faberi*, but distinguished by its subentire leaves, very small flowers, short pedicels and its short, persistent style.